Technical Research Note 189

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RAPID SCREENING OF TACTICAL IMAGERY AS A FUNCTION OF DISPLAY TIME

by James A. Thomas and Robert Sadacca

Support Systems Research Division

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U. S. Army
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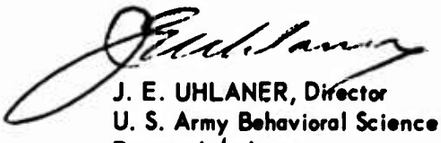
FOREWORD

The SURVEILLANCE SYSTEMS Project has as its objective the development of scientific research data bearing on the extraction of information from imagery and the products of other sensors, and the efficient storage, retrieval, and transmission of information with an advanced computerized image interpretation facility. Research results are used in future systems design and in the development of enhanced techniques and procedures for all phases of the image interpretation process within the data reduction facility.

The MAN-COMPUTER FUNCTIONS Task is one of four research Tasks established in the Support Systems Research Division of BESRL to concentrate on operational segments of the surveillance system. One major effort of the Task is devoted to the development and evaluation of input/output procedures for the description and transmission of tactical intelligence information. The present study concentrated on two work methods of rapid screening to determine the presence or absence of military targets and work methods of setting priorities for detailed interpretation of selected frames of imagery.



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RAPID SCREENING OF TACTICAL IMAGERY AS A FUNCTION OF DISPLAY TIME

BRIEF

Requirement:

To assess the effectiveness in the rapid screening of tactical imagery of two techniques for selecting a limited number of frames of high intelligence potential for detailed interpretation and to determine the effects of time allowed per frame on the effectiveness of the two techniques.

Procedure:

Two samples of image interpreters (N's of 33 and 30), each sample consisting of three matched groups, screened three sets of imagery at three display time intervals--5, 15, and 25 seonds per frame for Sample 1, and 10, 20, and 30 seconds per frame for Sample 2. Subjects scanned each print for the prescribed time while performing two screening functions: (1) annotating on the frame all areas of military activity detected, and (2) assigning priority ratings of High, Medium, and Low to indicate the estimated intelligence value of the frame. The two methods were compared in terms of accuracy rate and validity at the different display intervals.

Findings:

Priority ratings were better indexes of the information potential of the frames than were the annotations. The ratings, of high accuracy even with short viewing time, improved both in accuracy and in validity with longer display time. The validity of the ratings was higher with sets of imagery characterized by relatively few target areas and less complex background.

The validity of the number of annotations on a frame, generally low, did not increase with increased display time. More incorrect as well as correct annotations were made.

Utilization of Findings:

The priority rating method of screening is sufficiently accurate to be useful even where only very short screening time can be allowed. However, imagery differing in complexity may require adjustments in screening time.

RAPID SCREENING OF TACTICAL IMAGERY AS A FUNCTION OF DISPLAY TIME

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RAPID SCREENING OF TACTICAL IMAGERY AS A FUNCTION OF DISPLAY TIME

BACKGROUND AND OBJECTIVES

Consistent with efforts to improve the reaction time of military forces, the Army is developing mobile tactical image interpretation facilities (TIIF) designed to help speed the flow of intelligence information obtained by aerial surveillance. As a consequence of rapid advances in aerial surveillance system technology, including the development of telemetry and multi-sensor platforms, the amount of imagery to be interpreted by a TIIF can reach overwhelming proportions at peak load times. Future TIIF's may often be required to process large amounts of imagery with great rapidity, at the same time maintaining acceptable levels of accuracy and completeness.

The projected volume of imagery raises human factors problems for both the TIIF team chief and individual interpreters: What is the optimal method of processing the imagery? Should it be screened first, then interpreted? If the imagery is screened, what is the best method of identifying frames of greatest potential for later interpretation? What realistic workloads can be assigned? What are realistic screening rates? Are such rates differential, depending on the characteristics of the imagery? The general purpose of the present study was to investigate one of these problems, namely, the effect of variations in display time--that is, rate of screening--on interpreter performance in screening tactical imagery.

Screening is the process of selecting from a mass of imagery those frames which have high intelligence value for subsequent more detailed interpretation. As defined here, screening does not include or exclude the process of mentally identifying specific targets--suspicion that a frame contains targets or at least signs of military activity would presumably underlie its selection for further study. The desired result of the screening process, however, is not specific identifications but a set of photographs with greater than average information potential or intelligence value.

The procedure for screening tactical imagery used in the study was divided into two activities. First, the screener annotated areas of suspected military activity directly on the frame of imagery he was examining. He then assigned a priority rating based on the estimated intelligence value of the frame. Both actions were accomplished by the screener within fixed time periods ranging from 5 to 30 seconds per frame. The principal objectives of the experimentation were (1) to assess the accuracy and validity of the annotations and of the priority ratings, and (2) to determine the effect of variations in display time on screening performance.

METHOD

Subjects

Two samples of image interpreters about to graduate from the Image Interpretation Course of the U. S. Army Intelligence School at Fort Holabird, Maryland served as subjects. Each sample was divided into three groups matched on rights and wrongs scores on three standard performance measures. Sample 1 contained 11 subjects in each group, Sample 2 contained 10 subjects in each group, making a total N of 63.

Performance Measures

The three performance measures used in the study were selected to provide contrasting geographical and terrain conditions. The set of imagery for each measure consisted of 15 conventional black and white photographs typical of the "hard copy" with which the image interpreter is familiar. All photographs in a given set were taken from the same flight line. Scale on the three sets of photographs was reasonably similar.

Performance Measure T-17[1]. Imagery covered the coast of Florida. Terrain conditions were fairly homogeneous, consisting of heavily wooded areas with small clearings. Terrain was intersected by improved and unimproved roads. Scale was 1 : 8,400.

Performance Measure T-18. Imagery, taken during World War II, covered the Bastogne area along the Luxembourg-Germany border. Photos were taken after a heavy snowfall. Terrain features included groups of buildings, lightly wooded areas, with some roads. Scale was 1 : 9,300.

Performance Measure T-21. Photos of the Vire-Mortain, Brittany, were also taken during World War II. Terrain was typically agricultural, with numerous small plots of land surrounded by trees or hedgerows and presenting a mosaic-like appearance. Several photos showed heavily wooded areas. Scale was 1 : 10,000.

Apparent military activity in the imagery was denoted by vehicle trackage, wheeled and tracked vehicles, gun positions, observation and control points. Objects and features varied considerably within a given set and between sets. The number of areas of military activity in each print in each set is presented in Appendix A.

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[1] Designations show the location of the imagery in the BESRL library of image interpretation performance measures.

Research Design

The three performance measures were administered to each sample. The three groups within a sample were all administered the same three sets of imagery but in a different order and with different display intervals--5, 15, and 25 seconds per frame for Sample 1, and 10, 20, and 30 seconds per frame for Sample 2. All other aspects of the experiment were the same for the two samples. Also of some concern was the possible practice effect which might influence performance in the three trials. The design employed, therefore, was a 3 x 3 x 3 x 3 Graeco-Latin square--display time x performance measures x order (group) x trials. The overall designs for the two samples are outlined in Figure 1.

Sample 1

Order	Trials		
	1	2	3
Group A	T-17 5 secs	T-18 15 secs	T-21 25 secs
Group B	T-18 25 secs	T-21 5 secs	T-17 15 secs
Group C	T-21 15 secs	T-17 25 secs	T-18 5 secs

Sample 2

Order	Trials		
	1	2	3
Group A	T-17 10 secs	T-18 20 secs	T-21 30 secs
Group B	T-18 30 secs	T-21 10 secs	T-17 20 secs
Group C	T-21 20 secs	T-17 30 secs	T-18 10 secs

Figure 1. Graeco-Latin square experimental design for Samples 1 and 2

Screening Procedures

Each group was instructed to scan each print in a set for the prescribed display time. During this time, each interpreter first annotated all areas of military activity that he detected on the print by drawing circles around each area, restricting the size of the circle to the area of activity as much as possible. He then assigned to each print a priority rating of High, Medium, or Low, based on the potential intelligence information contained in the print. Before administration of a set of imagery, the experimenter demonstrated the duration of the time interval each frame would be displayed. All administrations were timed by stop watch. The complete instructions are given in Appendix B.

Dependent Variables

The main concern of the experiment was the accuracy and validity of the annotations and priority ratings across the six screening time intervals. Differences attributable to the groups within a sample were of little concern. However, the influence of the performance measures (the sets of imagery) and of the trials (the practice effect) on screening performance was of interest. The effect of the four experimental conditions--time, group, set of imagery, trial--was determined for seven dependent variables:

1. Total number of correct annotations, summed across 15 frames in a set.

2. Completeness of annotations. Total number of correct annotations divided by the total number of areas of military activity in 15 frames.

3. Total number of incorrect annotations.

4. Accuracy of annotations. Total number of correct annotations divided by the total number of annotations made in 15 frames.

5. Validity of annotations. Correlation, across 15 frames, between the number of annotations (correct and incorrect) made on each frame by the subject and the number of areas of military activity on the frame.

6. Accuracy of priority ratings. Number of frames for which the interpreter's ratings of High, Medium, and Low were the same as that of expert interpreters divided by 15.

7. Validity of priority ratings. Correlation, across 15 frames, between the priority ratings given by the subject and the number of areas of military activity on the frame.

Statistical Analysis

Analyses of variance consistent with the Graeco-Latin square design were computed for the seven dependent variables. Since the two samples were matched, the mean squares of the two samples were tested for significant differences, where the data permitted. Where appropriate, in order to provide a continuum in display time from 5 to 30 seconds, the data for the two samples were combined for presentation in tabular form. This approach facilitated exploration of optimal display intervals for a given dependent variable. Where analysis of variance of correlation coefficients was computed, the coefficients were converted using the r to z transformation.

RESULTS--ANNOTATIONS PROCEDURE

Number of Correct Annotations

The mean number of correct annotations generally increased as the display interval increased (Table 1). This result was consistent with expectations, since the longer display time afforded the interpreter more opportunity to look at suspected areas and to make more correct--as well as incorrect--annotations. The analysis of variance for both samples yielded highly significant results for screening time, indicating that significantly different numbers of correct annotations were made for the different time intervals (See Appendix C). There were no significant differences in correct annotations attributable to the other main effects (group, trial, sets of imagery). In none of the analyses conducted for the other dependent variables were significant differences obtained which could be attributed to group or trial effects. There were, however, significant performance measure effects on other variables. All analysis of variance data are presented in Appendix C.

Table 1

MEAN NUMBER OF CORRECT ANNOTATIONS AT EACH DISPLAY INTERVAL FOR SAMPLES 1 AND 2

Performance Measure	Display Time*					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	9.6	12.8	13.2	13.7	20.4	19.4
T-18	9.3	9.2	14.5	17.1	17.5	14.7
T-21	12.2	1.9	15.5	11.6	16.4	18.9
Mean	10.3	8.0	14.4	14.1	18.1	17.7

*$P < .01$ for 5, 15, 25 seconds (Sample 1) and for 10, 20, 30 seconds (Sample 2).

Completeness of Annotations

Of additional interest is the question, "Of the total amount of military activity present in the imagery, what percentages were annotated at each of the various display intervals?" In the results, completeness varied significantly as a function of screening time and performance measure. Table 2 shows that mean completeness across the three measures tended to increase with an increase in display time.

A highly significant main effect for performance measures reflected the difference in the percentages of total information extracted from the three different sets of imagery constituting the performance measures. It had not been possible to match the imagery in the different sets in terms of the number of areas of military activity shown. Table 3 shows that the more target areas in a given set, the lower the mean completeness. On the surface, the significant differences in completeness would seem attributable either to differences in the number of areas of activity in the imagery set or to the complexity of the imagery--or to the interaction of the two factors.

Table 2

MEAN COMPLETENESS OF ANNOTATIONS FOR SAMPLES 1 AND 2

Performance Measure**	Display Time*					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	.14	.18	.19	.20	.29	.28
T-18	.09	.09	.14	.16	.17	.14
T-21	.09	.01	.11	.08	.12	.14
Mean	.11	.10	.14	.15	.19	.19

*$P < .01$ for 5, 15, 25 seconds (Sample 1) and for 10, 20, 30 seconds (Sample 2).
**$P < .01$ for performance in both samples.

Table 3

MEAN COMPLETENESS OF ANNOTATIONS FOR SETS OF IMAGERY WITH VARYING NUMBERS OF TARGET AREAS

Performance Measure	Mean Completeness	No. of Areas of Military Activity	Mean No. of Areas Correctly Ident.
T-17	.21	69	14.9
T-18	.13	104	13.9
T-21	.09	134	12.7

Number of Incorrect Annotations

The analyses of variance for both samples yielded significant differences in number of incorrect annotations for varying display intervals. The mean number of incorrect annotations generally increased with increased time (Table 4). This finding is similar to previous BESRL findings for unspeeded interpretation performance. The longer interpreters look at imagery, the greater the total number of responses--correct and incorrect--they make.

Table 4

MEAN NUMBER OF INCORRECT ANNOTATIONS FOR SAMPLES 1 AND 2

Performance Measure	Display Time*					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	9.09	12.40	20.27	20.80	26.45	27.80
T-18	16.36	3.20	17.55	17.40	29.91	19.60
T-21	18.08	20.00	16.91	15.40	32.00	30.00
Mean	14.55	11.80	18.24	17.99	29.45	25.80

*P < .01 for 5, 15, 25 seconds (Sample 1) and for 10, 20, 30 seconds (Sample 2).

Accuracy of Annotations

In the analysis of variance for this variable, neither sample produced any significant main effects. Such a finding indicates that mean accuracy of annotation in screening is not affected by variations in display time. Essentially, the annotations made during a 5- or 10-second screening interval were just as accurate as those made during a 25- or 30-second interval (see Table 5). Similarly, there was little difference in the mean accuracy for the different performance measures.

Table 5

MEAN ACCURACY OF ANNOTATIONS FOR SAMPLES 1 AND 2

Performance Measure	Display Time					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	.51	.51	.37	.42	.46	.43
T-18	.37	.32	.47	.51	.39	.46
T-21	.46	.35	.50	.47	.49	.45
Mean	.44	.39	.44	.47	.44	.44

Validity of Total Number of Annotations

The validity of the annotations was measured for each interpreter by the correlation between the total number of annotations made on each of the 15 frames in a performance measure and the number of areas of military activity actually on the frame. In general, the obtained coefficients were low, especially those obtained in Sample 2 at 10, 20, and 30 seconds display time (Table 6). There was no evidence of significant variation in validity as a function of display time in either sample. The validity index reflects the extent to which the number of annotations recorded is proportional to the number of actual areas. Thus, the slow or cautious subject was not necessarily penalized as compared to the faster subject whose average number of annotations may have more closely approached the actual number of areas on the frames.

Table 6

MEAN VALIDITY COEFFICIENTS OF TOTAL NUMBER OF ANNOTATIONS FOR SAMPLES 1 AND 2

Performance Measure*	Display Time					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	.45	.06	.43	-.24	.53	-.22
T-18	.21	.04	.39	-.01	.36	-.06
T-21	.13	.08	.02	-.12	-.06	-.03
Mean	.26	.06	.28	-.12	.28	-.10

*$P < .01$ for performance measures in both samples.

Validity coefficients obtained for performance measure T-21 were significantly lower than those obtained for the other two measures--practically zero, in fact, for all display intervals. Although T-21 had the largest number of areas of military activity, the mean performance of the subjects in number of correct and incorrect annotations was poorest on this measure. As indicated earlier, the images comprising T-21 were more complex or heterogeneous in content than were images in the other two measures.

RESULTS--PRIORITY RATINGS PROCEDURE

Under this method of screening, it was assumed that in the quick-time or near real-time situation, the image interpreter is presented with a large number of frames of imagery, each frame being displayed for a brief time. The interpreter has to decide very quickly whether a frame contains sufficient information to be earmarked for further analysis and interpretation. The primary question which arises in this regard is, "What effect does the length of time an image is displayed have on the accuracy and validity with which frames are assigned priorities?"

Accuracy of Priority Ratings

The accuracy with which the interpreters assigned ratings of High, Medium, and Low to prints of tactical imagery did not vary significantly for display intervals of 5, 15, and 25 seconds (Sample 1); however, there were significant differences in the rating accuracy for display times of 10, 20, and 30 seconds--and for the different performance measures as well (Table 7). Note that the ratings tended to be more accurate for the longer display times--20, 25, and 30 seconds. Also, the ratings assigned to performance measure T-17, the set of images containing the fewest areas of military activity, tended to be more accurate than ratings assigned to the other sets.

Table 7

MEAN ACCURACY OF PRIORITY RATINGS FOR SAMPLES 1 AND 2

Performance Measure**	Display Time*					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	.53	.59	.49	.62	.63	.59
T-18	.42	.48	.49	.45	.50	.58
T-21	.50	.36	.45	.51	.53	.58
Mean	.48	.47	.48	.53	.55	.58

*$P < .01$ for 10, 20, and 30 seconds (Sample 2).
**$P < .01$ for performance measures for Sample 2.

Validity of Priority Ratings

The validity of the priority ratings was measured by the correlation between the ratings made by the subjects and the number of areas of military activity actually on the frames. Unlike the validity of the annotations, the validity of the ratings tended to increase with increased display time (Table 8). Also unlike the annotations, the validity coefficients for ratings in Sample 2 were not markedly different from those in Sample 1. However, as with the annotations, the validity coefficients of the priority ratings for Performance Measure T-21 were close to zero.

Table 8

MEAN VALIDITY COEFFICIENTS OF PRIORITY RATINGS FOR SAMPLES 1 AND 2

Performance Measure**	Display Time*					
	5 sec.	10 sec.	15 sec.	20 sec.	25 sec.	30 sec.
T-17	.38	.44	.31	.58	.60	.56
T-18	.44	.33	.30	.35	.45	.52
T-21	-.11	-.19	-.16	-.03	-.08	.00
Mean	.24	.19	.15	.30	.32	.36

*$P < .05$ for 5, 15, 25 seconds (Sample 1) and for 10, 20, 30 seconds (Sample 2).
**$P < .01$ for performance measures in both samples.

SUMMARY OF RESULTS

1. Both the number of correct and the number of incorrect annotations made by the interpreters significantly increased with an increase in display time.

2. The completeness of the annotations made by the interpreters increased significantly with an increase in screening time, and also varied significantly for the different performance measures.

3. The accuracy of annotations and the validity of the total number of annotations made by the interpreters were not influenced by variations in screening time.

4. The accuracy of the priority ratings significantly increased over screening times of 10, 20, and 30 seconds, but not over screening times of 5, 10, and 15 seconds.

5. The validity of the priority ratings increased with an increase in screening time, and also varied significantly for the different performance measures.

IMPLICATIONS OF THE FINDINGS

Results definitely favored the priority ratings over the annotation screening technique. In general, the priority ratings provided more valid indexes of the number of areas of military activity in the frames than did the annotations. Although the number of correct annotations increased with display time, the fact that the number of incorrect annotations increased as well allowed no overall gain in accuracy. The validity of the total number of annotations was generally low, and did not vary significantly with screening time. This result is particularly important since total number of annotations made on a frame might have been considered a valid index of the value of the frame. The priority ratings, on the other hand, improved both in accuracy and validity with longer display time. The ratings were surprisingly accurate in both samples, even for the short display times.

Note that the scale of the imagery used in the study was somewhat smaller than is much current operational tactical imagery. In view of the high validity of ratings obtained with the imagery used, investigation of ratings could well be extended to imagery of larger scale. Screening time of less than 5 seconds may be effective with large-scale frames. Also, the use of rating scales with more than the three points of High, Medium, and Low would be expected to increase the reliability and hence the validity of the priority assignments.

With regard to the consistent differences in screening performance found among the three performance measures, the inference is that the differences were due for the most part either to the complexity of the background in the imagery or to the varying numbers of military activity areas (since quality and scale were similar). Generally, performance was better on the two measures which were less complex and showed fewer target areas (T-17 and T-18) than on the third measure (T-21). The prints in T-21 presented a mosaic-like appearance due to the numerous plots of farmland. The numerous edges presented to the eye constituted a natural partitioning of the display and may have distracted the interpreters. Longer display times than were used in the study are probably necessary for scanning complex imagery.

Major implications with regard to the ratings are as follows:

1. Although the accuracy and validity of ratings varied significantly among different sets of imagery, the absolute levels of these indexes were sufficiently promising, even for very short screening times, to suggest the use of such ratings in some operational screening tasks.

2. Considering screening times of 30 seconds or less, the longer the time allowed for screening, the more accurate and valid are interpreters' ratings of the potential intelligence value of frames of imagery.

3. More refined rating procedures, a wider sample of imagery, and a greater range of display and viewing conditions might well yield more definitive results with regard to optimum display time.

APPENDIXES

APPENDIX A

DISTRIBUTION OF NUMBERS OF AREAS OF MILITARY ACTIVITY
BY SETS OF IMAGERY

Print Number	T-17	T-18	T-21
1	0	5	11
2	0	16	18
3	0	2	9
4	0	3	5
5	10	2	14
6	14	18	0
7	10	10	16
8	3	8	11
9	2	8	4
10	1	10	6
11	9	7	2
12	7	4	6
13	5	5	3
16	3	3	15
15	5	3	14
Σ	69	104	134

APPENDIX B

GENERAL INSTRUCTIONS TO EXAMINEES

Distribute set of imagery T- -S. Then say:

PUT YOUR NAME ON THE ENVELOP. NOW YOU WILL HAVE 5 SECONDS TO ACCOMPLISH THE STEPS PREVIOUSLY DESCRIBED FOR EACH PRINT IN THE PACKET. BEFORE YOU BEGIN, LET ME GIVE YOU AN IDEA OF HOW LONG 5 SECONDS ARE. I'LL START THE WATCH NOW. Pause for 5 seconds. Then say:

STOP! BY THIS TIME YOU SHOULD HAVE MADE YOUR ANNOTATIONS AND YOUR JUDGMENT OF HIGH, MEDIUM, OR LOW PRIORITY. ALL RIGHT, PLACE THE FIRST PHOTO IN FRONT OF YOU. READY? BEGIN!

After 5 seconds have elapsed, say: STOP! TAKE YOUR NEXT PRINT. READY? BEGIN!

After 5 seconds have elapsed, say: STOP! Continue this procedure until all fifteen prints have been completed; then have them replace the prints in the packet.

Distribute the next packet, T- -S. Then say:

PUT YOUR NAME ON THE ENVELOP. NOW YOU WILL HAVE 15 SECONDS TO ACCOMPLISH THE STEPS PREVIOUSLY DESCRIBED FOR EACH PRINT IN THE PACKET. BEFORE YOU BEGIN, LET ME GIVE YOU AN IDEA OF HOW LONG 15 SECONDS ARE. I'LL START THE WATCH NOW. Pause for 15 seconds. Then say:

STOP! BY THIS TIME YOU SHOULD HAVE MADE YOUR ANNOTATIONS AND YOUR JUDGMENT OF HIGH, MEDIUM, OR LOW PRIORITY. ALL RIGHT, PLACE THE FIRST PHOTO IN FRONT OF YOU. READY? BEGIN!

After 15 seconds have elapsed, say: STOP! TAKE UP YOUR NEXT PRINT. READY? BEGIN!

After 15 seconds have elapsed, say: STOP! Continue this procedure until all fifteen prints have been completed; then have them replace the prints in the packet.

Distribute the next packet, T- -S. Then say:

PUT YOUR NAME ON THE ENVELOP. NOW YOU WILL HAVE 25 SECONDS TO ACCOMPLISH THE STEPS PREVIOUSLY DESCRIBED FOR EACH PRINT IN THE PACKET.

BEFORE YOU BEGIN, LET ME GIVE YOU AN IDEA OF HOW LONG 25 SECONDS ARE. I'LL START THE WATCH NOW. Pause for 25 seconds. Then say:

STOP! BY THIS TIME YOU SHOULD HAVE MADE YOUR ANNOTATIONS AND YOUR JUDGMENT OF HIGH, MEDIUM, OR LOW PRIORITY. ALL RIGHT, PLACE THE FIRST PHOTO IN FRONT OF YOU. READY? BEGIN!

After 25 seconds have elapsed, say: STOP! TAKE YOUR NEXT PRINT. READY? BEGIN!

After 25 seconds have elapsed, say: STOP! Continue this procedure until all fifteen prints have been completed; then have them replace the prints in the packet.

APPENDIX C

ANALYSIS OF VARIANCE TABLES

Table C-1

SUMMARY OF ANALYSIS OF VARIANCE--NUMBER OF CORRECT ANNOTATIONS

Source	Sample 1			Sample 2		
	df	ms	f	df	ms	f
Between Subjects	32	64.5		29	97.9	
Groups	2	20.5	.304	2	285.7	3.399
Subjects W Groups	30	67.4		27	84.0	
Within Subjects	66	49.1		60	53.6	
Trials	2	61.4	1.739	2	10.7	.404
Sets	2	7.9	.215	2	155.7	5.855*
Screening Times	2	492.9	13.963*	2	723.0	27.192*
Error Within	60	35.3		54	26.6	
TOTAL	98	54.1		89	68.0	

*P < .01

Table C-2

SUMMARY OF ANALYSIS OF VARIANCE--COMPLETENESS OF ANNOTATIONS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects	32	.007		29	.009	
Groups	2	.009	1.286	2	.016	1.778
Subjects W Groups	30	.007		27	.009	
Within Subjects	66	.008		60	.010	
Trials	2	.015	4.08	2	.002	.667
Sets	2	.089	24.18*	2	.152	50.667*
Screening Time	2	.064	17.39*	2	.064	21.333*
Error Within	60	.004		54	.003	
TOTAL	98	.007		89	.010	

*P < .001

Table C-3

SUMMARY OF ANALYSIS OF VARIANCE--NUMBER OF INCORRECT ANNOTATIONS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects	32	374.8		29		
Groups	2	123.3	.31	2	603.9	1.09
Subjects W Groups	30	391.6		27	553.3	
Within Subjects	66	167.5		60		
Trials	2	148.5	1.36	2	269.9	3.72
Sets	2	104.1	.95	2	258.8	2.88
Screening Time	2	1989.1	18.12*	2	1465.4	20.17*
Error Within	60	109.5		54	72.6	
TOTAL	98	235.2		89	269.2	

*P < .01

Table C-4

SUMMARY OF ANALYSIS OF VARIANCE--ACCURACY OF ANNOTATIONS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects	32	.041		32	.075	
Groups	2	.035	.8631	2	.068	.8679
Subjects W Groups	30	.041		30	.078	
Within Subjects	66	.035		66	.032	
Trials	2	.006	.1849	2	.05(	1.7420
Sets	2	.049	1.3850	2	.089	.2751
Screening Time	2	.028	.8021	2	.041	1.2767
Error Within	60	.035		60	.032	
TOTAL	98	.064		98	.047	

Table C-5

SUMMARY OF ANALYSIS OF VARIANCE--ACCURACY OF PRIORITY RATINGS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects	32	.0004		32	.0005	
Groups	2	.0001	.1931	2	.0001	.2122
Subjects W Groups	30	.0004		30	.0005	
Within Subjects	66	.0006		66	.0006	
Trials	2	.0007	1.3639	2	.0020	4.9169
Sets	2	.0012	2.1699	2	.0029	7.1582*
Screening Time	2	.0014	2.6126	2	.0022	5.4307*
Error Within	60	.0005		60	.0004	
TOTAL	98	.0005		98	.0006	

*P < .01

Table C-6

SUMMARY OF ANALYSIS OF VARIANCE--VALIDITY OF ANNOTATIONS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects						
Groups	2	.02	.23	2	.12	1.66
Subjects W Groups	30	.10		27	.07	
Within Subjects						
Trials	2	.13	1.23	2	.01	.12
Sets	2	1.59	15.50**	2	.14	1.76
Screening Time	2	.04	.40	2	.35	4.34*
Graeco-Latin Error	0	.25		0	.02	
Latins x S/G	60	.10		54	.08	

*P < .05
**P < .01

Table C-7

SUMMARY OF ANALYSIS OF VARIANCE--VALIDITY OF PRIORITY RATINGS

Source	Sample 1			Sample 2		
	df	MS	F	df	MS	F
Between Subjects						
Groups	2	.15	1.43	2	.04	.44
Subjects W Groups	30	.10		27	.09	
Within Subjects						
Trials	2	.04	.60	2	.04	.57
Sets	2	3.62	50.13**	2	3.62	50.64**
Screening Time	2	.37	5.08**	2	.31	4.25*
Graeco-Latin Error	0	.09		0	.08	
Latins x S/G	60	.07		57	.07	

*P < .05
**P < .01

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5 AUTHOR(S) (Last name, first name, initial)

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13 ABSTRACT Rapid advances in Army aerial surveillance system technology, including the development of telemetry and multi-sensor platforms, has intensified the need for development of improved future systems design as well as enhanced techniques and procedures for all phases of the image interpretation process. The principal objectives of the experimental study reported in Technical Research Note 189 were to assess the effectiveness of two techniques for rapid screening to select imagery frames of high military potential and to determine the effects of variations in display time on screening performance. Two samples of image interpreters, each consisting of three matched groups, screened three sets of imagery at three different display time intervals (5, 15, and 25 seconds per frame for Sample 1; 10, 20, and 30 seconds per frame for Sample 2). Each interpreter was instructed to perform two screening functions while scanning each print--1) annotate on the frame all areas of military activity he detected; and 2) assign to each print a priority rating of High, Medium, or Low to indicate estimated intelligence value of the frame. Interpreter performance under the two methods was compared in terms of accuracy and validity of the annotations and priority ratings across the six screening time intervals. Results of the study definitely favored the priority ratings technique over annotation screening. The ratings, of high accuracy even with short viewing time, improved significantly both in accuracy and in validity with longer display time. Generally, performance was better on the measures which were less complex and showed fewer target areas. Validity of the number of annotations on a frame, generally low, did not vary significantly with display time. More incorrect as well as correct annotations were made, a finding similar to previous BESRL findings for unspeeded interpretation performance.

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14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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